

Audio/Modem Riser Specification

Revision 1.0

Intel Corporation



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Intel Corporation
2111 NE 25th Avenue
Hillsboro, OR 97124
Attn.: Russ Hampsten MS JF2-53

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Revision History

Version 1.0 - June 30, 1998

- Public release of specification.

1 Introduction

The Audio/Modem Riser (AMR) Specification is an open industry-standard specification that defines a hardware scalable Original Equipment Manufacturer (OEM) motherboard riser board and interface, which supports both audio and modem. The specification's main objective is to reduce the baseline implementation cost of audio and modem, while also addressing specific functional limitations of today's audio and modem subsystems.

PC Users' demand for feature-rich PCs, combined with the industry's current trend towards lower cost, mandates higher levels of integration at all levels of the PC platform. Motherboard integration of the modem subsystem has been problematic to date, in large part due to FCC and other international telecom certification processes that delay the introduction of a motherboard, had the modem's analog I/O (codec and DAA) circuitry been physically soldered to it. Resolving the homologation/certification issue for modems is one of the AMR specification's key objectives. By physically partitioning the portion of the modem that must be certified (analog I/O) onto a separate riser module, the motherboard development cycle is decoupled from any delays that would be associated with the certification process.

Motherboard integration of the audio subsystem has also been problematic, and remains a significant obstacle to realizing full signal to noise ratio (SNR) offered by today's audio codecs.

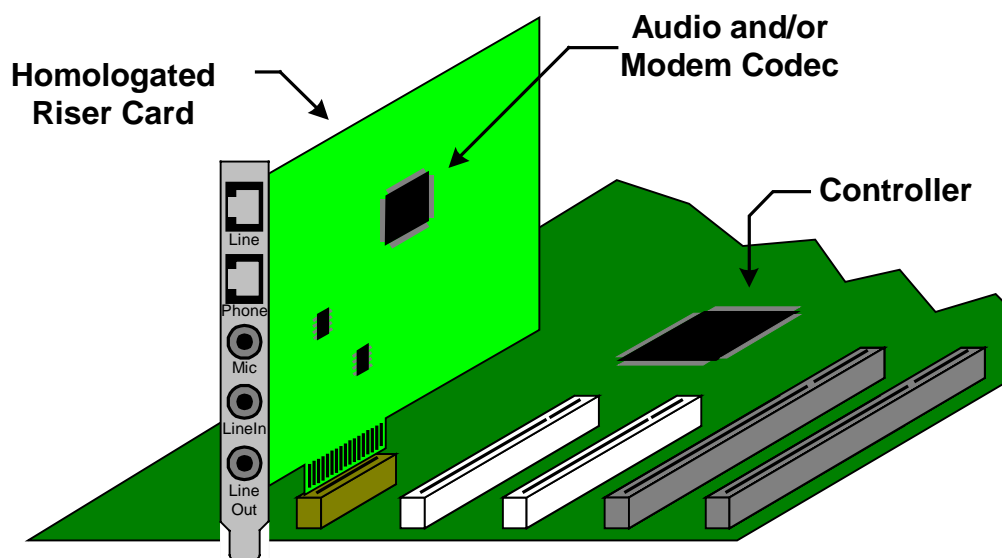


Figure 1. Audio/Modem Riser concept

With an open, industry standard riser solution, a system manufacturer is free to implement audio and/or modem on the motherboard at a lower bill of materials (BOM) cost than would be possible by deploying these functions in either industry standard expansion slots or in a proprietary method. With the added flexibility that hardware scalability brings, a system manufacturer has many motherboard acceleration options available, all stemming from the baseline AMR interface.

Note that the AMR Specification does **NOT** define an aftermarket standard I/O expansion slot. This document defines a system manufacturer, motherboard-only, riser interface that is intended to be fully configured prior to the initial shipment of the system. Standard I/O expansion slots, such as those supported by the PCI bus architecture, are intended to continue serving as the retail channel upgrade medium.

This specification defines the AMR architecture, required electrical characteristics of the riser interface, mechanical, and thermal requirements.

1.1 Related Documents

- Audio Codec '97 Component Specification Revision 2.1
(<http://developer.intel.com/pc-supply/platform/ac97>)
- Audio/Telephony Integration
(<http://developer.intel.com/pc-supply/platform/ac97/papers.htm>)
- Hardware Acceleration and Re-direction of Audio Streams
(<http://developer.intel.com/pc-supply/platform/ac97/papers.htm>)
- AC '97 Controller/Codec/System Recommendations
(<http://developer.intel.com/pc-supply/platform/ac97/papers.htm>)
- ACPI (Advanced Configuration and Power Interface) Specification
(<http://www.teleport.com/~acpi/>)
- PCI Bus Power Management Interface Specification Revision 1.1
(<http://www.pcisig.com>)
- Instantly Available PC Power Management Design Guide
(<http://developer.intel.com/design/power/pcpower.htm>)
- Instantly Available PC Power Delivery Requirements and Recommendations
(<http://developer.intel.com/design/power/supply98.htm>)

2 Architectural Overview

The following sections provide an overview of the baseline architecture along with descriptions of both supported and unsupported AMR configurations. Included in the following sections are different configurations of audio and modem, either up on the riser module, or physically soldered down on the motherboard printed circuit board (PCB). In addition, the model for hardware scalability is described.

2.1 Baseline Riser Architecture

Figure 2 illustrates the baseline architecture of a motherboard with support for an AMR module.

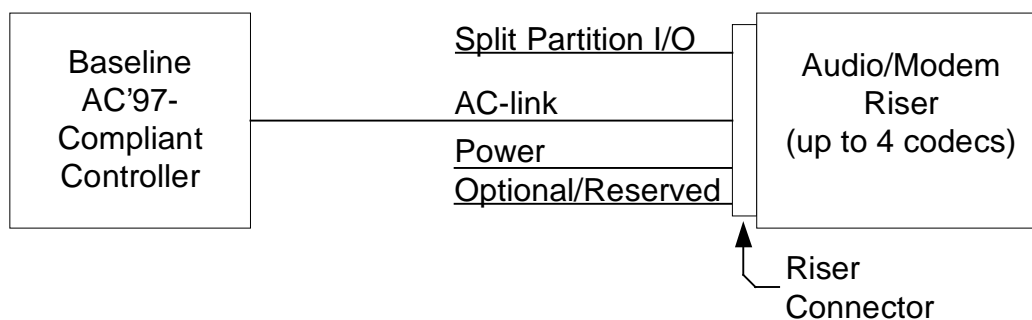


Figure 2. Baseline Audio/Modem Riser

The back bone of the AMR interface is an AC'97-compliant AC-link with support for up to four codecs.

Additional signals on the AMR interface support:

- **Split Partition I/O:** Signals used in split codec implementations (for example, audio codec on the motherboard, and the modem codec up on the AMR module). These signals include legacy analog I/O for call progress monitoring.
- **Power:** Signals that are required to support Instantly Available PC power management, as well as the main power supplies to operate the AMR module support circuitry.
- **Optional/Reserved:** Signals, which are required to support future features such as G.lite modem.

2.2 Audio-Down Split Codec Partition

This configuration takes advantage of the split codec partitioning enabled by the AC'97 Revision 2 specification. A system manufacturer can implement audio-down on the motherboard and modem-up on the AMR module. Using this configuration decouples the certification-burdened portion of the modem subsystem from the motherboard.

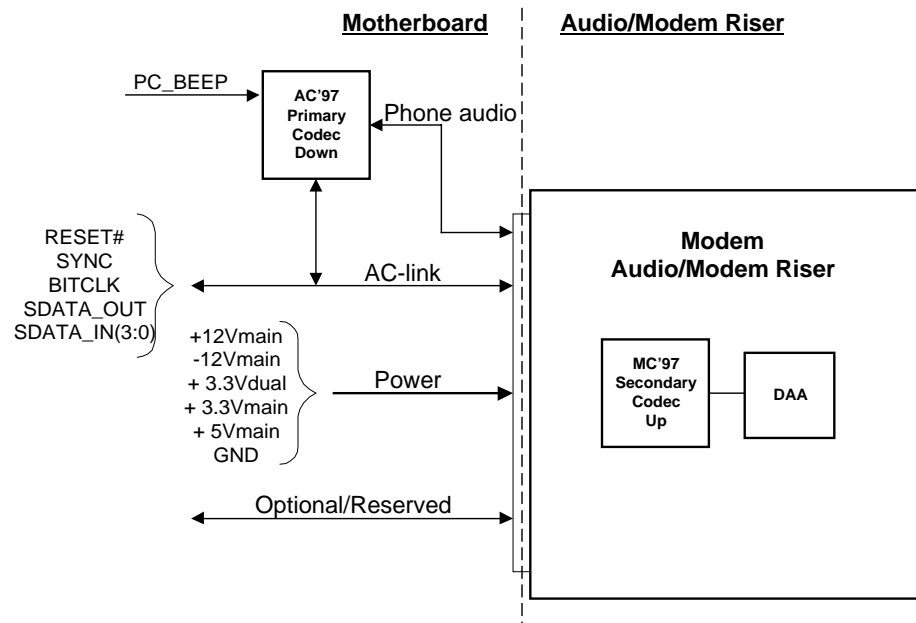


Figure 3. Split Codec Partition: AC'97 down; MC'97 Riser Module

2.3 Minimum Featured Motherboard with Split Codec Partitioned Riser Module

This configuration deploys both the audio codec and the modem codec up on the riser module. In this configuration, the motherboard could be a minimally featured board in which a system manufacturer has the opportunity to populate an audio-only riser, a modem-only riser, or an audio-plus-modem riser, depending upon the riser module selected.

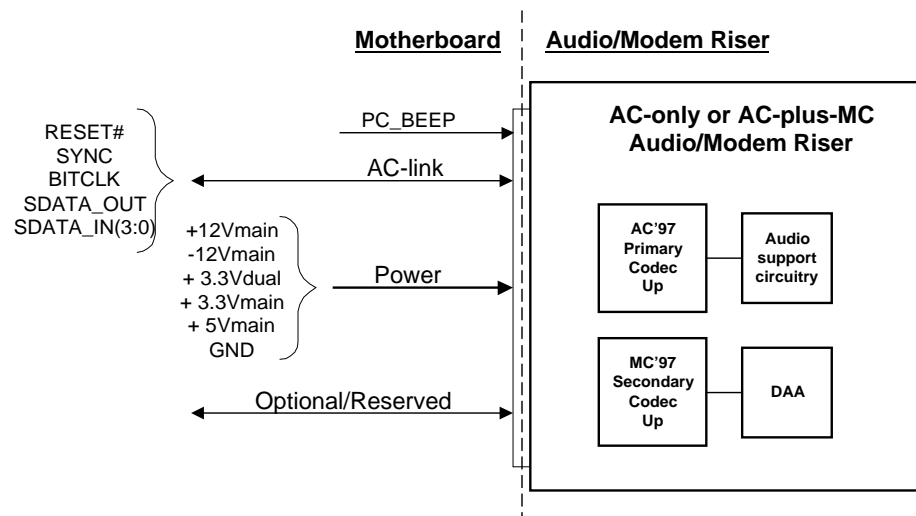


Figure 4. Split Codec Partition: AC'97 only, MC'97 only, or AC'97-plus-MC'97 Riser Module

2.4 Minimum Featured Motherboard with AMC'97 Riser Module

This configuration, which employs an AMC'97 combined audio/modem codec, introduces the highest level of integration, and arguably, the lowest implementation cost for audio and modem.

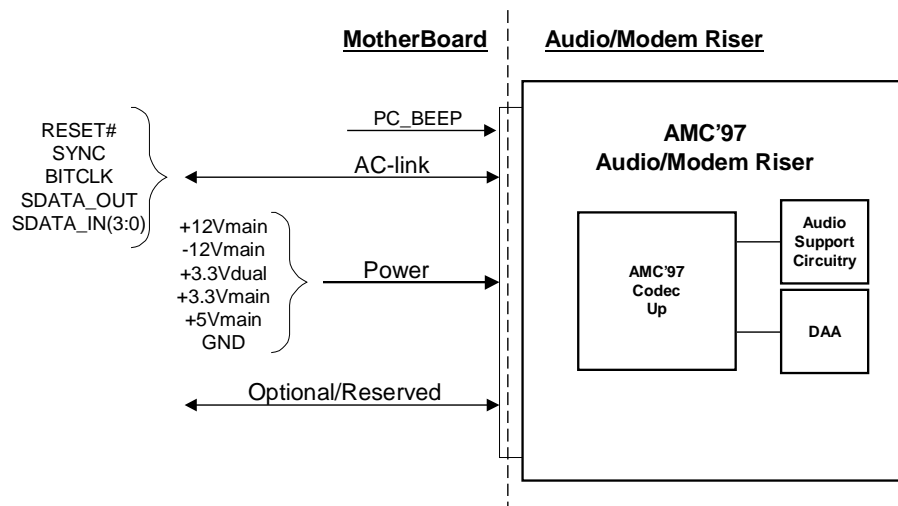


Figure 5. AMC'97 combined codec Riser Module

2.5 Unsupported Configurations

All AMR configurations must be limited to a single primary codec, with up to three secondary codecs. Any AMR configuration with more than a single primary codec is unsupported, and will likely result in improper system behavior and/or component damage. The required support for PRIMARY_DN# pin functionality ensures that only one primary codec can ever reside on the AC-link for a given AMR configuration. Refer to Section 3.2.1 for details.

2.6 Hardware Scalability Model

The baseline AMR architecture supports an “in-line” hardware acceleration model for both the audio and modem subsystems. In-line acceleration is the optimum form of hardware acceleration. An in-line accelerator is situated between the source of the pre-processed data and the final destination for the processed data. An accelerator fetches pre-processed data directly from main memory, processes it, and then passes it directly to the codec(s) via the AC-link.

A system manufacturer may layout their motherboard with provisions to support a baseline controller with a stuffing option for a PCI-based hardware accelerated controller.

The following figure illustrates the AMR architecture’s support for hardware acceleration. Further information can be found in the AC'97 whitepaper entitled “Hardware Acceleration and Re-direction of Audio Streams” which can be found at: (<http://developer.intel.com/pc-supp/platform/ac97/papers.htm>).

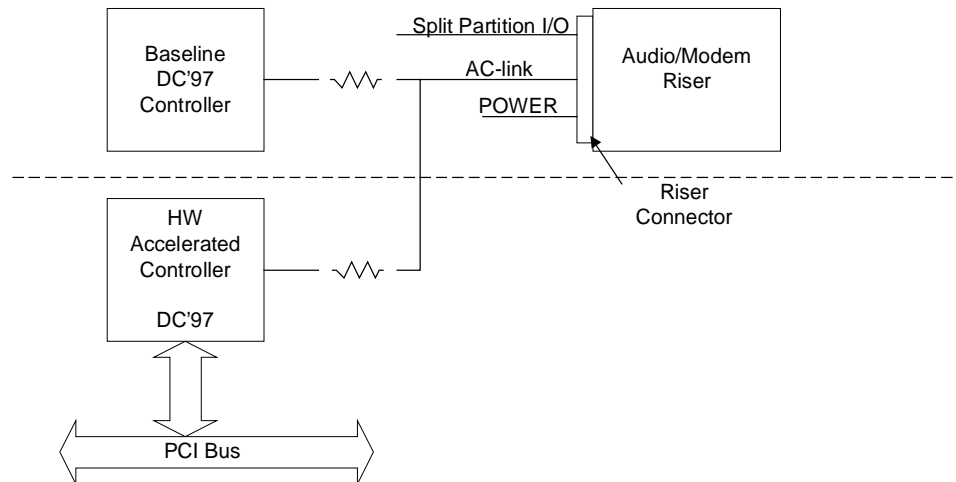


Figure 6. Audio/Modem Riser Hardware Scalability

The AMR architecture's hardware scalability enables a system manufacturer to choose which controller to deploy as the master of the AC-link. The "selectable" controller arrangement, utilizing series resistors¹, provides a simple method for an accelerated controller to fully replace the baseline controller. From the perspective of the riser module, an AC'97-compliant controller is mastering the AC-link. The riser module cannot discern whether it is being mastered by the baseline, or accelerated controller.

At motherboard design time a system manufacturer may design in provisions for a certain hardware-accelerated controller solution which, when mated with the capabilities of compatible riser modules, creates a range of possible motherboard solutions.

The AMR architecture does **NOT** support aftermarket audio or modem upgrades by only changing the AMR module. Once a system manufacturer has shipped a system into the field, regardless of the motherboard/riser configuration capabilities, all future audio or modem upgrades must be brought into the system via industry-standard expansion vehicles such as a PCI bus expansion slot or a Universal Serial Bus (USB) port.

3 Electrical Requirements

3.1 Signal Names and Pinout

The AMR Interface Connector is the interface between the motherboard and the AMR module. The connector provides all of the necessary signals to support several different configurations of audio and modem in the system. These configurations include audio and modem codecs on the Riser, audio on the motherboard and modem on the Riser, or no audio with modem on the Riser.

3.2 ATX, microATX, and NLX Audio/Modem Riser Interface Connector

The following sections provide detailed information regarding the signals on the AMR Interface Connector, including signal names, descriptions, electrical properties, and pin number assignments for the ATX, microATX, and NLX form factors.

3.2.1 ATX, microATX, and NLX Audio/Modem Riser Interface Connector Pin Out

This section describes the signals, which appear on the AMR Interface Connector for the ATX, microATX, and NLX form factors. Signals designated as Input are sourced from the motherboard. Signals designated as Output are sourced from the AMR module. Those signals defined as In/Out may be sourced from either the motherboard or the AMR module.

¹ The resistor values should be chosen for the best signal quality. The baseline controller's resistor values may not necessarily be the same value as those of the accelerated controller.

Figure 7, following the pin description tables, shows the pin-out of the AMR Interface Connector for the ATX, microATX, and NLX form factors.

Signal Name	Type	Pin Number	Signal Description
AC97_BITCLK	In/Out	A23	Serial data clock from primary codec to AC'97 Controller and any non-primary codecs. The nominal frequency of this signal is 12.288MHz. For detailed information, refer to the current version of the AC'97 Component Specification. AC97_BITCLK is an output from a primary codec and an input to non-primary codecs. The reset state of this signal must meet the current version of the AC'97 Component Specification.
AC97_SYNC	Input	A17	Synchronization pulse from an AC'97-compliant controller to all of the AC'97-compliant codecs on the link. This signal is nominally a 1.3µs wide pulse, which is used to synchronize the AC link. For detailed information, refer to the current version of the AC'97 Component Specification. The reset state of this signal must meet the current version of the AC'97 Component Specification.
AC97_SDATA_OUT	Input	B17	AC'97 serial data from an AC'97-compliant controller to all of the AC'97-compliant codecs on the link. For detailed information, refer to the current version of the AC'97 Component Specification. The reset state of this signal must meet the current version of the AC'97 Component Specification.
AC97_SDATA_IN0	Output	A21	AC'97 serial data from a primary AC'97-compliant codec to an AC'97-compliant Controller. For detailed information, refer to the current version of the AC'97 Component Specification. The reset state of this signal must meet the current version of the AC'97 Component Specification.
AC97_SDATA_IN1	Output	A19	AC'97 serial data from a second AC'97-compliant codec to an AC'97-compliant Controller. For detailed information, refer to the current version of the AC'97 Component Specification. The reset state of this signal must meet the current version of the AC'97 Component Specification. Note that this signal is not currently supported in the NLX Motherboard Specification. The NLX Specification owners are being petitioned to include this signal.
AC97_SDATA_IN2	Output	B21	AC'97 serial data from a third AC'97-compliant codec to an AC'97-compliant Controller. For detailed information, refer to the current version of the AC'97 Component Specification. The reset state of this signal must meet the current version of the AC'97 Component Specification. Note that this signal is not currently supported in the NLX Motherboard Specification. The NLX Specification owners are being petitioned to include this signal.
AC97_SDATA_IN3	Output	B19	AC'97 serial data from a fourth AC'97-compliant codec to an AC'97-compliant Controller. For detailed information, refer to the current version of the AC'97 Component Specification. The reset state of this signal must meet the current version of the AC'97 Component Specification. Note that this signal is not currently supported in the NLX Motherboard Specification. The NLX Specification owners are being petitioned to include this signal.
AC97_RESET#	Input	B18	Active low AC'97 link reset signal. For detailed information, refer to the current version of the AC'97 Component Specification. The reset state of this signal must meet the current version of the AC'97 Component Specification.
PRIMARY_DN#	Input	B6	Indicates the presence, or absence, of a primary codec situated on the motherboard. When at a logic low level, the PRIMARY_DN# signal indicates, to the AMR module, that a primary codec is present on the motherboard. This required signal is intended to be used to preclude contention on the AC-link, which would be the result of having more than one codec, on the AC-link, configured as a primary. PRIMARY_DN# must be pulled to the wake voltage source of the AMR module. A motherboard employing a primary codec down on the motherboard must connect the PRIMARY_DN# pin to ground on the motherboard. The motherboard and AMR module manufacturers must coordinate their designs when using the PRIMARY_DN# signal.

Table 1 – Required ATX/microATX/NLX Audio/Modem Riser Interface Connector digital signals

Signal Name	Type	Pin Number	Signal Description
MONO_PHONE	Output	A2	Mono audio signal from the modem subsystem to the audio subsystem on the motherboard. The primary uses for this signal include implementing a speakerphone, and for call progress monitoring of a modem connection (during dial, connect, and training).
MONO_OUT/PC_BEEP	Input	B3	When the audio sub-system is located on the motherboard, this pin is defined as the MONO_OUT signal. It is used to route a mono audio signal from the audio subsystem on motherboard to modem subsystem, for use in implementing a speakerphone. When the audio sub-system is located on the AMR module this pin is defined as the PC_BEEP signal. It is used to route the motherboard beep/speaker signal from the motherboard to the audio sub-system, for use in hearing POST codes.

Table 2 – Required ATX/microATX/NLX Audio/Modem Riser Interface Connector Analog Audio Signals

Signal Name	Type	Pin Number	Signal Description
+12V	Supply	B9	Positive 12- volt main power supply
-12V	Supply	B7	Negative 12-volt main power supply
+5VD	Supply	B11	Positive 5-volt main digital power supply
+3.3VD	Supply	B15	Positive 3.3-volt main digital power supply
+3.3Vdual/+3.3VSB	Supply	A15	Positive 3.3-volt main/standby power supply. +3.3Vdual supply provides full-rated power capacity during working or full-on state, and a limited power capacity during sleep or suspended states. When +3.3Vdual is not available, this pin must be connected to a +3.3-volt standby power source.
Ground	Ground	B10	Power supply ground return for +12V
Ground	Ground	B8	Power supply ground return for -12V
Ground	Ground	B12	Power supply ground return for +5VD
Ground	Ground	B16	Power supply ground return for +3.3VD
Ground	Ground	A16	Power supply ground return for +3.3Vdual/+3.3VSB
Ground	Ground	A22	Digital signal ground return for AC97_BITCLK signal
Ground	Ground	A18	Digital signal ground return for AC97_RESET#, AC97_SYNC and AC97_SDATAOUT signals
Ground	Ground	A20	Digital signal ground return for AC97_SDATA_IN0 and AC97_SDATA_IN1 signals
Ground	Ground	B20	Digital signal ground return for AC97_SDATA_IN2 and AC97_SDATA_IN3 signals
Ground	Ground	B2	Analog signal ground return for MONO_PHONE, MONO_OUT/PC_BEEP, AUDIO_MUTE#, and AUDIO_PWRDN signals

Table 3 – Required ATX/microATX/NLX Audio/Modem Riser Interface Connector Power and Ground Signals

Signal Name	Type	Pin Number	Signal Description
USB+	In/Out	A10	Positive side of the differential USB data signal. For more information, refer to the Universal Serial Bus Specification. The state of this signal during reset must meet the Universal Serial Bus Specification.
USB-	In/Out	A11	Negative side of the differential USB data signal. For more information, refer to the Universal Serial Bus Specification. The state of this signal during reset must meet the Universal Serial Bus Specification.
USB_OC	Output	A8	USB bus over-current signal. For more information, refer to the Universal Serial Bus Specification. The state of this signal during reset must meet the Universal Serial Bus Specification.
S/P_DIF_IN	Input	A13	This signal is an input to the riser card from the motherboard. It carries PCM audio or compressed AC-3* encoded audio. If supported, this signal must be properly buffered and available on the I/O back panel to route to an Audio/Video receiver, or other external device. If the motherboard does not support the S/P_DIF_IN signal, then the pin must be connected to ground on the motherboard at the AMR connector.
AUDIO_MUTE#	Input	B1	Signal from the motherboard to the riser, which is used to mute the audio subsystem. This is an optional signal that is only required for audio codecs that do not provide General Purpose Input/Output (GPIO). When AUDIO_MUTE is low, the audio amplifiers will be placed in the muted state. When high the audio amplifiers will function normally. The state of this signal during reset must be low. If the motherboard does not support the AUDIO_MUTE# signal, then the pin must be left floating on the motherboard at the AMR connector.
AUDIO_PWRDN	Input	A1	Signal from the motherboard to the riser, which is used to place the audio subsystem's external amplifiers in a low power state. This is an optional signal that is only required for audio codecs that do not provide GPIO. When AUDIO_PWRDN is high the audio amplifiers will be placed in a low power state. When low the audio amplifiers will function normally. The state of this signal during reset must be low. If the motherboard does not support the AUDIO_PWRDN signal, then the pin must be connected to ground on the motherboard at the AMR connector.
AC97_MSTRCLK	Input	B23	24.576MHz master clock for AC'97 link. This signal is optionally sourced from the motherboard to the riser in support of existing AC'97-compliant codecs and controllers. If the motherboard does not support the AC97_MSTRCLK signal, then the pin must be connected to ground on the motherboard at the AMR connector.
+5Vdual/+5VSB	Supply	A7	Positive 5-volt main/standby power supply (can be used for USB power). +5Vdual supply provides full-rated power capacity during working or full-on state, and a limited power capacity during sleep or suspended states. When a +5Vdual supply is not available, this pin can be connected to a +5 volt standby or the +5Vd power source. If +5VD is used then deep-sleep wake capabilities are not available.
Ground	Ground	A6	Power supply ground return for +5Vdual/+5VSB and USB_OC signals
Ground	Ground	B22	Digital signal ground return for AC97_MSTRCLK signal
Ground	Ground	A9	Ground return for the USB+ signal
Ground	Ground	A12	Ground return for the USB- signal
Ground	Ground	A14	Ground return for S/P_DIF_IN signal

Table 4 – Optional ATX/microATX/NLX Audio/Modem Riser Interface Connector Signals

Signal Name	Type	Pin Number	Signal Description
Reserved	Supply	B13	Reserved for future power supply requirements
Reserved	N/A	B14	Reserved
Reserved	N/A	A3	Reserved
Reserved	N/A	A4	Reserved
Reserved	N/A	A5	Reserved
Reserved	N/A	B4	Reserved
Reserved	N/A	B5	Reserved

Table 5 – Reserved ATX/microATX/NLX Audio/Modem Riser Interface Connector Signals

↑ I/O Shield (back of system) ↑			
B1	AUDIO_MUTE#	AUDIO_PWRDN	A1
B2	GND	MONO_PHONE	A2
B3	MONO_OUT/PC_BEEP	RESERVED	A3
B4	RESERVED	RESERVED	A4
B5	RESERVED	RESERVED	A5
B6	PRIMARY_DN#	GND	A6
B7	-12V	+5Vdual/+5VSB	A7
B8	GND	USB_OC	A8
B9	+12V	GND	A9
B10	GND	USB+	A10
B11	+5VD	USB-	A11
	KEY	KEY	
	KEY	KEY	
B12	GND	GND	A12
B13	RESERVED	S/P-DIF_IN	A13
B14	RESERVED	GND	A14
B15	+3.3VD	+3.3Vdual/+3.3VSB	A15
B16	GND	GND	A16
B17	AC97_SDATA_OUT	AC97_SYNC	A17
B18	AC97_RESET#	GND	A18
B19	AC97_SDATA_IN3	AC97_SDATA_IN1	A19
B20	GND	GND	A20
B21	AC97_SDATA_IN2	AC97_SDATA_IN0	A21
B22	GND	GND	A22
B23	AC97_MSTRCLK	AC97_BITCLK	A23

Figure 7. Audio/Modem Interface Connector pin-out for ATX, microATX, and NLX form factors

3.2.2 ATX, microATX, and NLX Audio/Modem Riser Interface Electrical Specifications

Signal Name	Min.	Max.	Units	Comments
PC_BEEP				
Amplitude	--	1.0	V _{rms}	Must be attenuated to a level compatible with audio codecs.
Source Impedance	2.0	2.5	kΩ	
Load Impedance	10	--	kΩ	
MONO_PHONE				
Amplitude	--	1.0	V _{rms}	
Load Impedance	10	--	kΩ	
MONO_OUT				
Amplitude	--	1.0	V _{rms}	
Source Impedance	--	1	kΩ	
Load Impedance	10	--	kΩ	
S/P_DIF_IN				
V _{IL}	--	0.35xV _{DD}	Volts	V _{DD} refers to the digital supply operating the circuitry on the AMR module, which interfaces to the specified signal.
V _{IH}	0.65xV _{DD}	--	Volts	
AUDIO_MUTE#				
V _{IL}	--	0.35xV _{DD}	Volts	V _{DD} refers to the digital supply operating the circuitry on the AMR module, which interfaces to the specified signal.
V _{IH}	0.65xV _{DD}	--	Volts	
AUDIO_PWRDN				
V _{IL}	--	0.35xV _{DD}	Volts	V _{DD} refers to the digital supply operating the circuitry on the AMR module, which interfaces to the specified signal.
V _{IH}	0.65xV _{DD}	--	Volts	
PRIMARY_DN#				
Pull-up resistance	10	0.35xV _{DD}	kohms	A nominal value of 50kohms is recommended V _{DD} refers to the digital supply operating the circuitry on the AMR module, which interfaces to the specified signal.
V _{IL}	0.65xV _{DD}		Volts	
V _{IH}			Volts	
USB+, USB-, USB_OC	--	--	--	Refer to the current version or release of the Universal Serial Bus Specification.
AC97_MSTRCLK, AC97_BITCLK, AC97_SYNC, AC97_SDATA_OUT, AC97_SDATA_IN0, AC97_SDATA_IN1, AC97_SDATA_IN2, AC97_SDATA_IN3, AC97_RESET#	--	--	--	Refer to the current version or release of the Audio Codec '97 Component Specification.
+12V				
Tolerance	--	±5	%	Measured at the power supply motherboard connector
Ripple Voltage	--	0.120	V _{PK-PK}	Measured at the power supply motherboard connector
Supply Current	--	0.500	Amps	
-12V				
Tolerance	--	±10	%	Measured at the power supply motherboard connector
Ripple Voltage	--	0.120	V _{PK-PK}	Measured at the power supply motherboard connector
Supply Current	--	0.100	Amps	
+5VD				
Tolerance	--	±5	%	Measured at the power supply motherboard connector
Ripple Voltage	--	0.050	V _{PK-PK}	Measured at the power supply motherboard connector
Supply Current	--	1.00	Amps	
+3.3VD				
Tolerance	--	±5	%	Measured at the power supply motherboard connector
Ripple Voltage	--	0.050	V _{PK-PK}	Measured at the power supply motherboard connector
Supply Current	--	1.00	Amps	
+5Vdual/+5VSB				
Tolerance	--	±5	%	Measured at the power supply motherboard connector
Ripple Voltage	--	0.050	V _{PK-PK}	Measured at the power supply motherboard connector
Supply Current	--			
Wake enabled		0.500	Amps	Support for one USB port
Non-wake enabled		0.500	Amps	
+3.3Vdual/+3.3VSB				
Tolerance	--	±5	%	Measured at the power supply motherboard connector
Ripple Voltage	--	0.050	V _{PK-PK}	Measured at the power supply motherboard connector
Supply Current	--			
Active State		0.150	Amps	
Wake enabled		0.150	Amps	
Non-wake enabled		0.020	Amps	
AMR Module Power Dissipation		15	Watts	

Table 6 – ATX/microATX/NLX Audio/Modem Riser Electrical Specifications

4 Power Management

The AMR architecture supports Instantly Available PC power management including full support for its “Off-yet Communicating” capabilities. The working state power sources delivered to the AMR connector enable normal working state operation, while auxiliary voltage sources are also delivered to the riser, enabling wake logic to remain active when the working state voltage rails have been shut off.

The following subsections focus on power management design considerations.

4.1 Riser Module Power Distribution

Power distribution is dependent upon the supported features of the riser module. The following subsections detail the power distribution requirements for each of the supported AMR module configurations.

- Audio-Only Riser Modules
- Modem-Only Riser Modules
- Audio and Modem Riser Modules

4.1.1 Audio-Only Riser Module

The audio subsystem is not required to function as a wake device when the system is in a sleep state.

The following table defines the recommended voltages for an audio only riser module:

	Vmain ²	+12Vmain	-12Vmain	+3.3Vdual
AC-link (codec signals)				
■ BIT_CLK	✓			
■ SDATA_IN	✓			
AC-link (controller signals)				
■ SYNC	✓			
■ RESET	✓			
■ SDATA_OUT	✓			
Riser digital logic	✓			
Riser analog circuitry		✓	✓	

Table 7 – Recommended Power Distribution: Audio-Only Riser Module

All riser module driven AC-link signals, as well as all other digital logic on the riser module must be powered by Vmain. The Vmain power supply must be used to power both the digital portion of the audio codec and the AC-link portion of the digital controller. In addition, it is recommended that the audio codec locally regulate the +12Vmain down to +5Vaa for use by its analog circuitry.

When the system enters a sleep state where the main power rails are shut off (that is, ACPI S3, or S4) the entire riser module shuts completely off, consuming no power.

² Vmain may be either the +3.3VD or +5VD power supply.

4.1.2 Modem-Only Riser Module

In support of an Instantly Available PC's "Off-yet Communicating" capabilities, modem riser modules are required to be capable of waking the system from a sleep state where the main power rails have been shut off. This implies the use of auxiliary power.

	Vmain	+12Vmain	-12Vmain	+3.3Vdual
AC-link (codec signals) ■ BIT_CLK ■ SDATA_IN				✓ (if MC is primary) ³ ✓
AC-link (controller signals) ■ SYNC ■ RESET ■ SDATA_OUT	✓ ✓			✓
Modem digital logic				✓
Modem analog circuitry		✓		
Modem wake logic				✓

Table 8 – Recommended Power Distribution: Modem-Only Riser Module

As Table 8 shows, all AC-link signals driven from the modem codec, as well as all modem codec digital and wake-related circuitry must be powered by an auxiliary +3.3 volt supply (+3.3Vdual).

4.1.3 Audio-plus-Modem Riser Modules

A key requirement for Audio-plus-Modem Riser modules is that they must be capable of achieving high audio quality through current best-known design methods, while not compromising the modem's ability to wake the system from any system state.

Table 9 depicts the power distribution that enables both high quality audio and "Off-yet Communicating" modem operation.

	Vmain	+12Vmain	-12Vmain	+3.3Vdual
AC-link (codec signals) ■ BIT_CLK ■ SDATA_IN(audio) ■ SDATA_IN(modem)	✓ ⁴ ✓ ⁴			✓
AC-link (controller signals) ■ SYNC ■ RESET ■ SDATA_OUT	✓ ⁴ ✓ ⁴			✓
Audio digital logic	✓			
Audio analog circuitry		✓	✓	
Modem digital logic				✓
Modem analog circuitry		✓		
Modem wake logic				✓

Table 9 – Recommended Power Distribution: Audio-plus-Modem Riser Module

All audio subsystem driven AC-link signals, as well as all other digital logic associated with the audio subsystem, must be powered by Vmain. It is recommended that the audio and/or modem subsystem locally regulate the +12Vmain down to +5Vaa for use by its analog circuitry.

All modem subsystem-driven AC-link signals, as well as all other riser module digital and wake-related circuitry that is associated with the modem subsystem must be powered by +3.3Vdual, enabling an Instantly Available PC.

³ This is typically a modem-only riser module in a system with no motherboard audio deployed.

⁴ In an AMC (audio/modem codec) device these AC-link signals may reside in either the Vmain or +3.3Vdual power wells.

4.1.3.1 Split Partition AC'97 and MC'97 Riser Module

In the case of a split partition implementation (audio codec on motherboard and modem codec on riser), the power distribution must be implemented as shown in Table 9. This allows the audio portion of a riser module to be powered from standard working state voltage sources that are shut off when the PC enters an ACPI sleep state of S3 or S4.

In order to support an Instantly Available PC, the modem portion of the riser module must draw its power from the +3.3V_{dual} auxiliary power source. This enables a modem codec to power its wake logic when in an S3 or S4 ACPI sleep state.

4.1.3.2 AMC'97 Combination Codec Riser Module

The AMC'97 combination codec riser module must implement the same power distribution strategy as for the split partitioned AC'97 + MC'97 riser module. This imposes a requirement on AMC'97 codec designs, in that they are designed with split power wells enabling multi-voltage power distribution for different sections of the component.

4.2 Reset Considerations

The AC'97 architecture defines 3 types of reset that AC'97-compatible codecs must comprehend.

1. Cold Reset Performs a complete codec hardware reset
2. Warm Reset Brings the AC-link out of PR4 low power mode, no internal initialization required
3. Register Reset Reinitializes the codec via a software command

Prior to AC'97 Version 2.1, when the PC is sleeping in either the ACPI S3, S4, or S5 states, and when a wake event occurs, the system brings the audio/modem subsystems back to full operation by reapplying power to the AC-link, and asserting a cold reset sequence⁵.

AC'97, Version 2.1 imposes a new requirement for AC-link RESET# behavior. This new requirement dictates that RESET# remain actively driven during S3, S4, or S5 states, so that auxiliary-powered modem codecs know, without doubt, that the AC-link RESET# was asserted, as opposed to floating at or near ground. +3.3V_{dual}-powered circuitry would then look for the trailing low-to-high transition on the AC-link RESET# signal which indicates that the AC-link was powered back up and a “resume” reset sequence had occurred.

This presents an issue for modem codecs that are designed to wake the system from S3 or S4 states. An auxiliary-powered modem codec must retain portions of its internal state, including the wake event state⁶, after experiencing this resume sequence. The root issue is that the auxiliary-powered codec must be capable of determining how to interpret and deal with the AC-link RESET# assertion, so that its internal state is not corrupted when resuming.

There are numerous ways, ranging from hardware-only solutions, to hardware/driver solutions, of addressing this without impacting either this specification or the AC'97 Component Specification. Disclosure of any detailed implementation-specific information is beyond the scope of this specification.

4.3 Clocking Considerations

4.3.1 ACPI S0 “Working State” Clocking

In a multiple codec design, where audio is the primary codec (that is, the source of BIT_CLK), ACPI S0 “working state” power management of the primary codec can present a clocking issue for the secondary codec. Specifically, take the case when the system is currently in the working state (ACPI S0) and the OS power management policy manager determines that the audio (primary codec) is idle. At this point, it may decide to transition the audio subsystem to its lowest power state (for example, D3hot). If the audio driver were to then place the audio codec down to its lowest power state (including PR4), the AC-link would enter its low power mode with BIT_CLK stopped.

Had the modem been in use, or needed at any point following this, it would be incapable of operating correctly since the audio driver has disabled its working state clock source (BIT_CLK).

For information on how this problem should be resolved, refer to the AC'97 Component Specification, Version 2.1.

⁵ This is the same treatment as with PCI functions resuming from D3cold with a hardware PCI bus reset sequence.

⁶ “PME context” in PCI-PM parlance

Note that in any event, the audio and modem drivers are required to remain mutually exclusive of each other (that is, they must not be required to have any knowledge of each other's state).

4.3.2 ACPI S3 and S4 “Sleeping State” Clocking

An MC'97 modem codec, when configured as the secondary codec⁷, depends upon BIT_CLK from the primary codec for its normal, working-state clock source. When the system is in an ACPI S3, or S4 sleep states⁸ the MC'97 must make provisions for a free-running clock source if needed for support of CallerID capture, or other wake-event related circuitry. This clock source must be powered by +3.3V_{dual}, and its frequency is recommended to be as low as is both economical and technologically possible to conserve power while the PC is asleep.

4.4 Ground Isolation

Ground isolation techniques are used to improve the separation of the digital noise from the quieter analog sections of a circuit board. The manufacturer of an AMR module may choose to implement isolated ground regions in the audio sections of the AMR module. To allow a system motherboard to take advantage of an AMR module with ground isolation, certain pins on the AMR Interface Connector can be used to pass the isolated ground from the AMR module to the motherboard. Table 10 identifies these ground pins for the AMR Interface Connectors.

	Pins for Isolated Ground
ATX/microATX/NLX AMR Interface Connector	B2

Table 10 – AMR Interface Connector pins for isolated ground

The manufacturer of both the motherboard and the AMR module must be sure to coordinate their designs when using isolated grounds.

4.5 Discovery, Configuration, and Control

Audio and modem subsystems implemented using the AMR architecture are to be considered motherboard devices only. The functional capabilities of the codec(s) residing on the riser module are fully visible to their corresponding device driver through the standard AC'97 audio and modem register files.

Identification and control of any additional component(s) or features on the riser (for example, the DAA) is the responsibility of the device driver that is shipped by the riser module manufacturer.

An AMR module is always seen by the system as a motherboard device. This, by definition, indicates that all pertinent functional information for every element of the design is readily available, eliminating the need for any automatic capability of discovery mechanisms, which would otherwise add unnecessary cost to the riser module.

If an AMR module absolutely requires feature identification, the audio and/or modem device driver may go about identifying the AMR module features by any number of means.

For example, a codec could be designed to latch a field of strapped pins when coming out of AC-link RESET#. These pins would then be encoded for any number of specific module designs. The encoded AMR module ID field could then be read back through one of the Vendor Specific AC '97 registers. An alternative approach could utilize a few AC-link general-purpose outputs to control a serial EEPROM on the module from which the driver could fetch the module's features.

4.6 EMI, RFI, and Shielding Requirements

It is the responsibility of the AMR module designer to ensure that the module does not prevent a system from meeting the required regulatory requirements concerning EMI and RFI.

5 Mechanical Requirements

The following sections provide the mechanical requirements for the AMR module and connector placement in the ATX, microATX, and NLX form factors.

⁷ The MC'97 modem codec is typically configured as the secondary codec.

⁸ Or any other state where the primary audio codec is not providing a free running BIT_CLK. (i.e., BIT_CLK is held low or unpowered)

5.1 ATX and microATX Motherboard Audio/Modem Riser Interface Connector Locations

Figure 8 shows the placement of an AMR Interface Connector on an ATX or microATX motherboard. Note that there are component height restrictions around the AMR Interface Connector. In addition, the AMR Interface Connector mechanical location is shown relative to the PCI and AGP connectors. Placement of the AMR connector relative to an ISA slot must be the same as the placement of a PCI connector relative to an ISA slot. This implies that the absolute placement of the AMR Interface Connector must be determined from the board specification for the appropriate form factor.

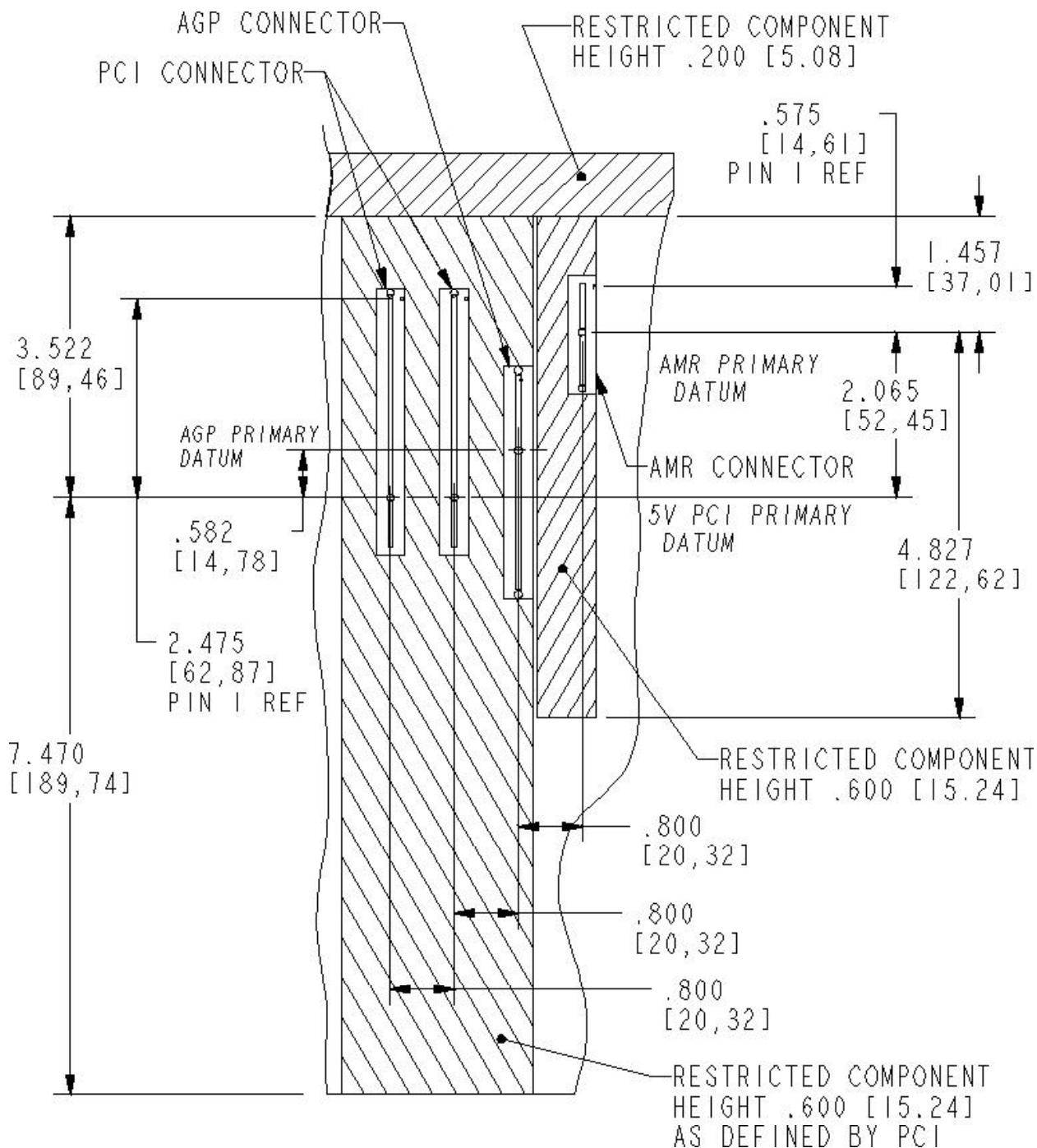


Figure 8. Audio/Modem Riser Interface Connector Locations for ATX and microATX Motherboards

5.2 NLX Riser Audio/Modem Riser Interface Connector Locations

Figure 9 shows the placement of an AMR Interface Connector on an NLX Riser. Note that there are component height restrictions around the AMR Interface Connector. In addition, the AMR Interface Connector mechanical location is shown relative to the PCI connector. Placement of the AMR connector relative to an ISA slot must be the same as the placement of a PCI connector relative to an ISA slot. This implies that the absolute placement of the AMR Interface Connector must be determined from the mechanical specification for the particular NLX Riser.

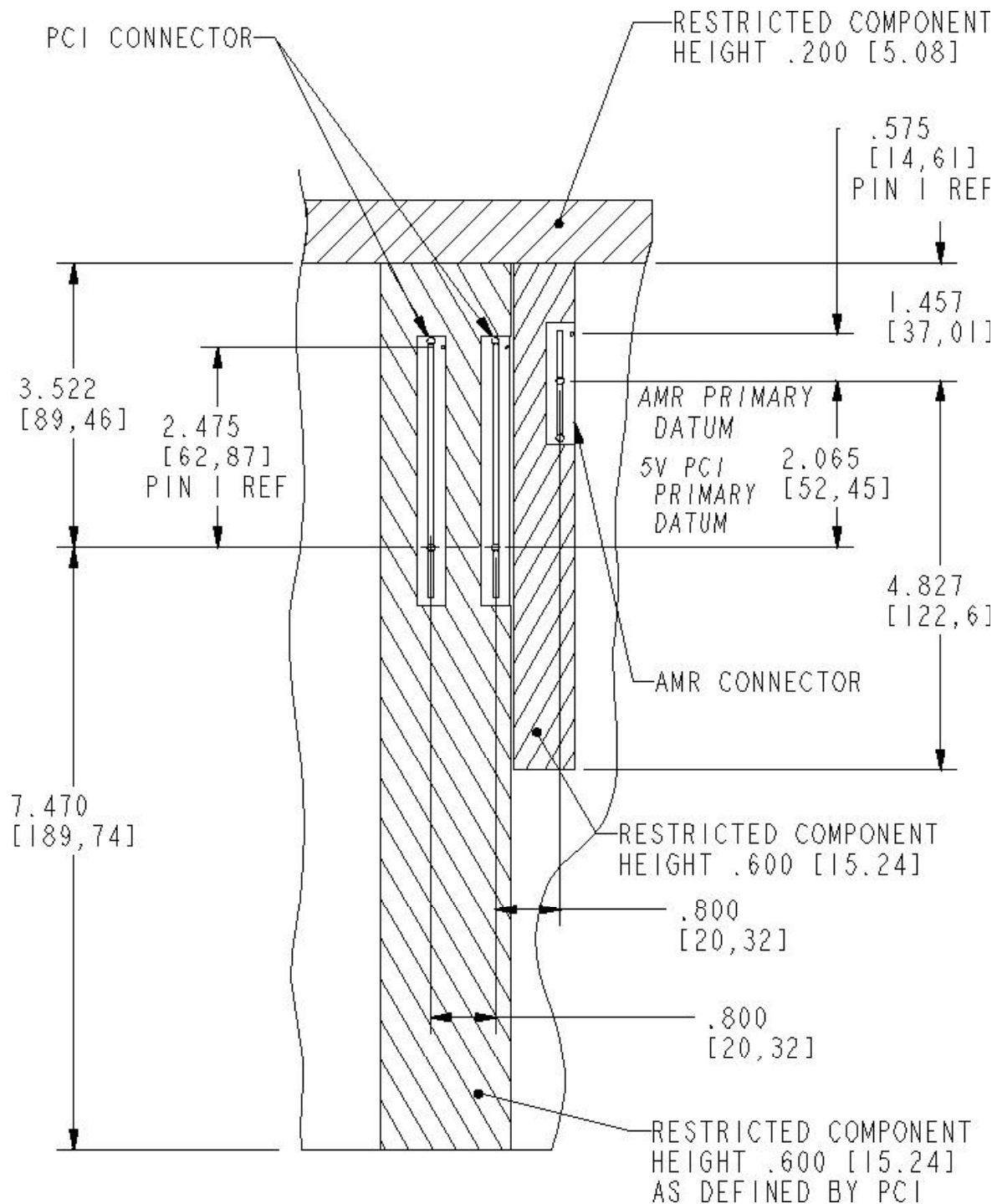


Figure 9. Audio/Modem Riser Interface Connector Locations on NLX Riser

5.3 Audio/Modem Riser Card Dimensions for ATX, microATX, and NLX form factors

Figure 10, below, shows the mechanical dimension information for an AMR module for the ATX, microATX, and NLX form factors. In addition to the component keep out areas shown on the drawing, there are component height restrictions for both the Primary and Secondary Component Sides of the board. The Primary Component Side of the AMR module must not contain any components that exceed 0.570 inches (14.48mm) in height. The Secondary Component Side of the AMR module must not contain any components that exceed 0.105 inches (2.64mm) in height.

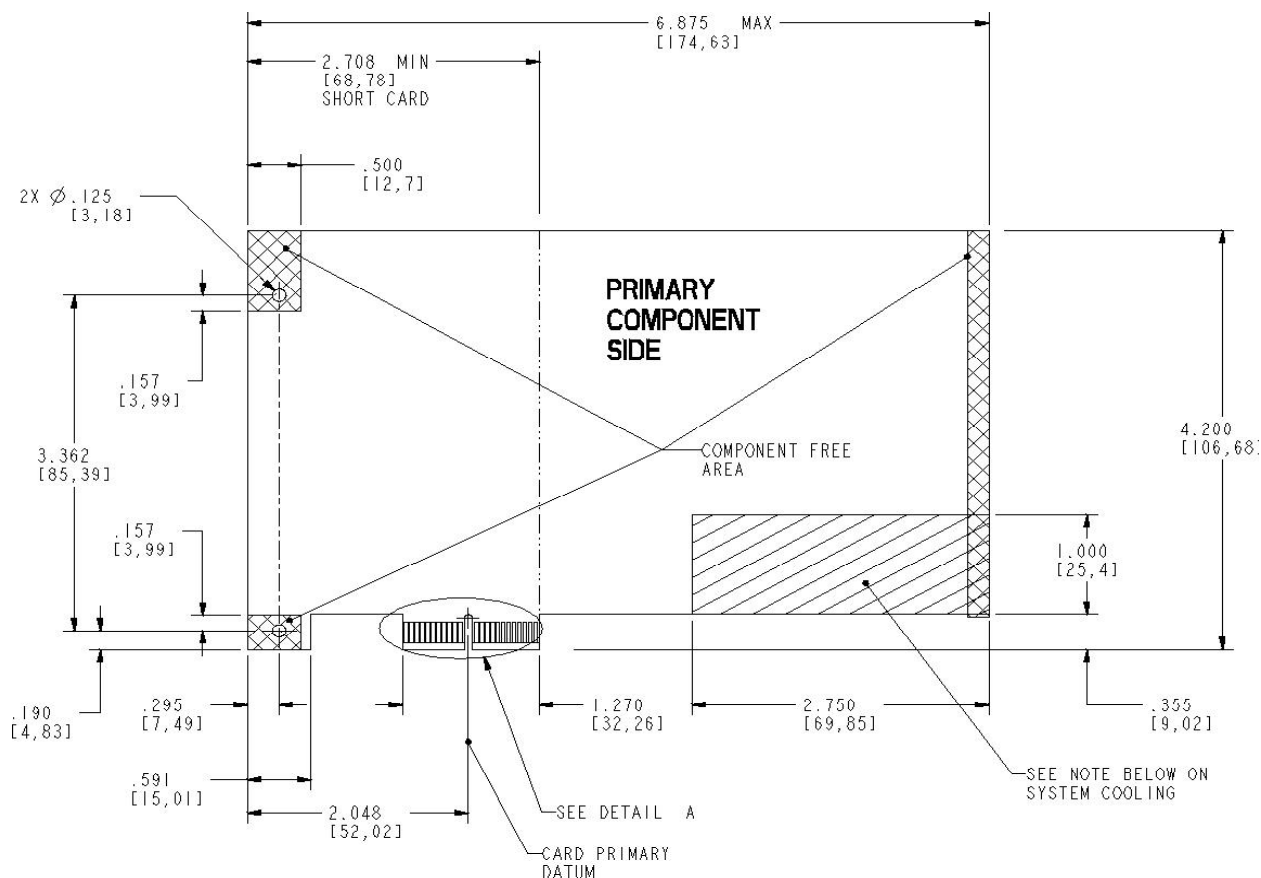


Figure 10. ATX, microATX, and NLX form factor Audio/Modem Riser card dimensions

System Cooling Implementation Note:

The hatched area in Figure 10, above, may be optionally cut away from the AMR module board outline to improve airflow in the system. A full-length AMR module may, under certain circumstances, significantly obstruct the airflow to the add-in card situated next to it. It is the responsibility of the system integrator, motherboard manufacturer, and the AMR module manufacturer to consider all of the cooling requirements for a given system design.

7 Motherboard Design Rules

The following sections provide the design rules for the various form factors, including ATX, microATX, and NLX. Adherence to these design rules is required in order to claim compliance with the AMR Specification.

7.1 ATX, microATX, and NLX Form Factor Design Rules

1. AMR Connectors must be placed in the outer slot locations on the ATX, microATX, and NLX form factors (for example, on a five-slot motherboard, the AMR connector must reside in either slot 3 or slot 7).
2. Maximum trace capacitance for any AC-link trace on an ATX, microATX, or NLX Motherboard must not exceed 25pF. This capacitance does not include the codec input/output capacitance, the input/output capacitance associated with the controller, or the capacitance associated with the AMR connector.
3. If the controller sourcing the AC-link signals does not incorporate internal pull-downs on the AC97_BITCLK and AC97_SDATA_IN(0-3) signals, then the motherboard must provide these pull-downs. The pull-down value must not be less than 10kohms.

8 Audio/Modem Riser Board Design Rules

The following paragraphs list the design rules for the various form factors, including ATX, microATX, and NLX. Adherence to these design rules is required in order to claim compliance with the AMR Specification.

1. Maximum trace capacitance in a two-codec implementation for any AC-link trace on the AMR module must not exceed 15pF. This capacitance does not include the codec input or output capacitance, or the capacitance associated with the AMR connector.
2. Maximum trace capacitance in a three-codec implementation for any AC-link trace on the AMR module must not exceed 20pF. This capacitance does not include the codec(s) input or output capacitance, or the capacitance associated with the AMR connector.
3. Maximum trace capacitance in a four-codec implementation for any AC-link trace on the AMR module must not exceed 25pF. This capacitance does not include the codec(s) input or output capacitance, or the capacitance associated with the AMR connector.
4. In order to ensure that the AMR module will function properly and reliably over the long trace lengths associated with the NLX form factor all AMR modules designed for the NLX form factor must be AC'97 Version 2.1-compliant.
5. The AMR and AC'97 Component specifications allows for either +3.3-volt or +5-volt digital I/O. Care must be taken to ensure that both sides of the AMR connector are driven from compatible voltage rails.